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A JOM ROUNDTABLE: Key Issues in Additive Manufacturing



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Learn more at: www.tms.org/TMS2020

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- TMS Director/Chair, Programming

Find complete job descriptions and qualifications for each office, as well as the Nominee Statement Form and nomination instructions, at: www.tms.org/BoardNominations

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The 2020–2021 fellowship begins September 1, 2020.

ALL APPLICATIONS ARE DUE JANUARY 3, 2020.





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About the Cover

In "Computational Modeling of the Mechanical Behavior of 3D Hybrid Organic-Inorganic Nanocomposites," Mohammad Maghsoudi-Ganjeh et al. describe a study in which a three-dimensional hybrid nanocomposite was analyzed using the cohesive finite element method. This model contained hard mineral nanograins bonded by a relatively soft and thin organic adhesive layer to mimic the ultrastructure of biological ceramics such as bone and nacre. The cover figure shows damage initiation in the thin layers of the adhesive phase.

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The scope of *JOM* (ISSN 1047-4838) encompasses publicizing news about TMS and its members and stakeholder communities while publishing meaningful peer-reviewed materials science and engineering content. That content includes groundbreaking laboratory discoveries, the effective transition of science into technology, innovative industrial and manufacturing developments, resource and supply chain issues, improvement and innovation in processing and fabrication, and life-cycle and sustainability practices. In fulfilling this scope, *JOM* strives to balance the interests of the laboratory and the marketplace by reporting academic, industrial, and government-sponsored work from around the world.

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in the final analysis

"The country would be a lot better off if we stopped having comment sections. And if we got rid of Twitter."

-Colin Powell



Number 11

November 2019

I'm not a big social media fan, and I find the "comments" section on any web site a generally soul-draining abyss. That said, I do like Twitter. I tinkered with being a regular tweeter a few years ago (@JJRofTMS), but I didn't quite find my groove. Some days I had it; some days, not so much. Disinterested more than defeated, I let Twitter go and channeled my energies in other directions. During that lull, Donald Trump became U.S. President and, in the process, awakened the world to the good and bad possibilities of using Twitter to communicate directly with supporters and non-supporters alike.

My leadership ranking is zepto-scale next to that of the U.S. President. Still, Twitter as a leadership platform had me regularly fielding comments along the lines of, "Hey, Jim, you need a Twitter account, too!" I'd brush such suggestions off with a derisive snort. But, little by little, I got to thinking: I've got an occasional insight to share and possess a certain editorial flourish with which to share it. Why not revisit @JJRofTMS and see if I can do a better job the second time around? So, a few months ago I resolved to see if I could average a tweet a day. Could I maintain the discipline through the end of 2019? Could I be interesting? Could I avoid self-serving indulgence? Could I dodge the trolls? Could I attract tens of thousands of followers? As of this writing, I'm a month in and so far so good. Indeed, I'm having fun with it.

So, what do I tweet? That's a question more easily answered by going to twitter.com/jjroftms. Be not afraid. In brief, think of it as a mini-version of In the Final Analysis; or, as described on my "profile" page, "The Minerals, Metals & Materials Society Executive Director providing news of @TMSSociety, materials science and engineering, business, and eclectic miscellany." I tweet primarily about TMS (e.g., our commitment to continuing the MS&T conference collaboration), business development (e.g., the ups and downs of metals markets), policy (e.g., what to do with plastic waste), management techniques (e.g., qualities in a good leader), and heaping dashes of "flavor" (e.g., the return of the Far Side cartoon or my favorite television show line ever). My most frequently viewed tweet concerned the fact that the guitarist of the band Queen, Brian May, has a Ph.D. in astrophysics from London's Imperial College. Inspiration comes from many sources . . . *The Wall Street Journal, The New York Times, TMS News, The Washington Post,* magazine articles, National Public Radio, books, movies, daydreaming, and countless web sites.

For the longest time, I thought of Twitter as a frivolous pursuit. Short, sweet, quickly consumed, and full of empty calories—effectively one of the many, many Twinkies of the Internet. My opinion has not changed a lot, but Twitter does attract a lot of eyes and impressionable minds. All too often, what is vended to them from many purveyors is faulty logic, dumb commentary, rampant adulatory, bounteous narcissism, and torrential prevaricating. I'd like to think that we can do better by bringing more reasoned and reasonable voices to the virtual rostrum. I'm not suggesting that I'm such person. No, I'm not even at the yocto-scale for Internet influencers. But there are others who have the vision, consequence, and articulacy to do so. Perhaps you know such a person; perhaps you are such a person?

Why let the louder and lesser voices be the vox populi? (I'm going to tweet that.)



James J. Robinson Executive Director

🥑 @JJRofTMS

"The Minerals, Metals & Materials Society Executive Director providing news of @TMSSociety, materials science and engineering, business, and eclectic miscellany."

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Do you have business or industry news of interest to the minerals, metals, and materials community? Submit your announcement or press release to Kaitlin Calva, JOM Magazine Managing Editor, at kcalva@tms.org for consideration.

In Case You Missed It: Business News from the Field

Preferred Bidder for British Steel Selected

London, United Kingdom: The U.K. government announced that Turkish company Ataer Holdings A.S. will enter exclusive talks to purchase British Steel. This follows the May 2019 order by the British High Court that British Steel Limited enter into compulsory liquidation overseen by the Official Receiver. Ataer Holdings, a subsidiary of Turkey's military pension fund, was selected from a pool of several interested parties and had previously outlined plans to invest \$1.1 billion into British Steel.

SK Capitals Expands Polymer Investment

New York, USA: SK Capital, a private investment firm focused on the specialty materials, chemicals and pharmaceuticals sectors, announced the signing of a definitive agreement to acquire the Performance Products & Solutions business "PP&S" from PolyOne Corporation in a transaction valued at approximately \$775 million. The acquisition includes PolyOne's GeonPerformance Materials brand and includes twelve manufacturing locations across North America and Asia. The sale is expected to be finalized in late 2019.



Vancouver, Canada: Canadian firm Los Andes Copper is proceeding with the development of a 111,000 tonne per day copper mine as part of its Vizcachitas project in Chile. The location's copper-molybdenum porphyry deposit, located approximately 100 miles northeast of Santiago, is one of the largest undeveloped deposits not held by a major mining company. Following the completion of a preliminary economic assessment, Los Andes Copper is currently preparing a prefeasibility study that it expects to submit by the end of 2020. (Photo courtesy of Los Andes Copper).

Halliburton Wins Kuwait Offshore Contract

Kuwait City, Kuwait: Kuwait Oil Company (KOC) has awarded a \$597 million Integrated Offshore Drilling Services contract to energy products and services provider, Halliburton. KOC is the official body responsible for the exploration, production and export of Kuwait's hydrocarbon resources. Halliburton is tasked with providing six high-pressure high-temperature (HPHT) exploration wells on two jack-up rigs in the Arabian Gulf. Work is expected to begin in mid-2020 and the contract includes a 3 year term with a 6-month extension option.

Solvay Sale Moves Towards Closure

Zwijnaarde, Belgium: DOMO Chemicals signed an agreement to acquire Solvay's Performance Polyamides Business in Europe for approximately \$330 million. The acquisition, which is subject to approval by the competent competition authorities, is expected to close by the end of 2019. This move will bring closure to a much larger transaction: BASF's \$1.8 billion purchase Solvay's global nylon 6,6 business. BASF's bid was approved by the European Commission in January 2019 with the stipulation that Solvay first divest the bulk of its European nylon 6,6 assets to a third party to avoid further restricting competition in an already concentrated industry.

Renewables to Power Oz Mining Project

Adelaide, Australia: Oz Minerals revealed in a recent progress update to its West Mustgrave Project that it expects heavy usage of renewable sources to power the copper and nickel mine in West Australia. Power accounts for around 40% of the processing cost at West Musgrave and, as such, the company is hoping to reduce its reliance on high cost fossil fuels by utilizing a 55MW hybrid diesel-solar-wind solution with 70-80% renewable penetration. A provider has not yet been selected.



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The Minerals, Metals & Materials Society

ESTABLISHING ASPIRATIONS

The 2018 TMS Annual Report

INTRODUCING TMS ASPIRES: A LETTER FROM TMS LEADERSHIP

Dear TMS Members,

Every three years, TMS develops a new strategic plan to guide the decisions and actions of Society leadership, establishing guidelines that permeate TMS culture. In 2018, the TMS Board of Directors ratified a new kind of strategic plan. We wanted to create more than a to-do list of projects; we wanted to inspire excitement for the Society's future and capture the aspirations of our members.

The result? **TMS Aspires**. The core of this new strategic plan, developed over the course of a year using input from volunteer and staff leaders, is a compact set of overarching goals:

- Goal 1. TMS aspires to be a highly inclusive society where all materials students and professionals feel welcome and diversity is celebrated.
- Goal 2. TMS aspires to be the place where global materials practitioners come together and participate in vibrant annual meetings, specialty conferences, courses, student activities, and other events.
- Goal 3. TMS aspires to be the society that envisions, defines, and enables the future by gathering and empowering materials experts to scope the future of materials science, engineering, and technology.

Taken together, these goals provide a portrait of what TMS can be. In this report, you will see just a few examples of how we have made progress toward these goals, and view a summary of our Society's membership, activities, and financial performance from the 2018 calendar year.

Sincerely,



Kevin J. Hemker, 2018 TMS President



James J. Robinson, TMS Executive Director

Moving Toward Goal 1.

In 2018, the TMS Board of Directors approved recommendations from two ad hoc committees that will advance inclusivity and increase diversity of gender, employment sector, and national affiliation within the TMS Fellows program.

Moving Toward Goal 2.

Drawing nearly 4,300 attendees to Phoenix, Arizona, the TMS 2018 Annual Meeting & Exhibition (TMS2018) was one of the largest annual meetings in TMS history. TMS was also an organizer of three new events in 2018: Additive Manufacturing Benchmarks 2018 (AM-Bench 2018), held at the National Institute of Standards and Technology (NIST) headquarters; a new, two-day course, Machine Learning for Materials Science; and the collaborative global metallurgy conference, Extraction 2018, organized in partnership with the Metallurgy & Materials Society of the Canadian Institute of Mining, Metallurgy & Petroleum and the Society for Mining, Metallurgy & Exploration.

Moving Toward Goal 3.

TMS continued its leadership in developing influential technology and roadmapping activities with studies that resulted in the release of two new reports in 2018: *Advanced Computation and Data in Materials and Manufacturing: Core Knowledge Gaps and Opportunities* (October 2018), organized by TMS on behalf of the U.S. National Science Foundation, and *Harnessing Materials Innovations to Support Next Generation Manufacturing Technologies* (March 2018), organized by TMS on behalf of the Alliance for Manufacturing Foresight (MForesight).



ESTABLISHING ASPIRATIONS The 2018 TMS Annual Report

ABOUT TMS IN 2018

THE IMPACT THAT WE HAVE

TMS journals continued their upward Impact Factor (IF) trend with the release of the 2018 Journal Citation Reports (Clarivate Analytics, 2019). The chart shown here demonstrates the progress of these impact factors for *JOM*, *Journal of Electronic Materials* (JEM), *Metallurgical and Materials Transactions A* (MMTA), and *Metallurgical and Materials Transactions B* (MMTB).



EVENTS WE HELD

TMS held large, multidisciplinary annual conferences, as well as more focused specialty conferences, workshops, and short courses. The following are 2018 events in which the Society had ownership, sponsorship, and/or management interest:



A dozen professional development courses and workshops were also held in conjunction with TMS2018, as well as four offered at MS&T18.

WHO WE ARE





WHAT OUR MEMBERS LIKE

Free subscriptions to the TMS member journal, JOM; technical meetings; and networking opportunities were the aspects of TMS that members reported valuing most in the **2018 TMS Member Survey.**

THE GOOD THAT WE DO

TMS unveiled *Materials Explorers™*, its STEM educational outreach initiative, at TMS2018, with the public launch of the program held at the Arizona Science Center in Phoenix. TMS encouraged its members to take the program's resources to their local schools.



2018 TMS BOARD OF DIRECTORS

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TMS 2018 FINANCIAL REVIEW

2018 Operating Revenues by Program Area



2018 Operating Expenses by Program Area



Summary of Operations Revenues and Expenses REVENUE

Membership & Customer Service	\$522,030	
Content	\$2,905,938	
Events, Education & Exhibits	\$4,281,040	
Volunteer Support	\$1,200	
Marketing & Communications	\$57,227	
NIScE	\$268,362	
Executive & Operations	\$322,125	
TOTAL REVENUES	\$8,357,922	

EXPENSES

Membership & Customer Service	\$299,018	
Content	\$926,966	
Events, Education & Exhibits	\$2,727,115	
Volunteer Support	\$757,500	
Marketing & Communications	\$415,087	
NIScE	\$679,455	
Executive & Operations	\$2,048,800	
TOTAL EXPENSES	\$7,853,941	
EXCESS OPERATIONS REVENUE	\$503,981	



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FOUNDATION 25 Years of GROWING THE COMMUNITY: 2018 ANNUAL REPORT







25 YEARS OF GROWING THE COMMUNITY: 2018 ANNUAL REPORT





Dear Friends of the TMS Foundation:

The 25th anniversary of the TMS Foundation was celebrated with another successful year of fulfilling our mission to support future generations within the minerals, metals, and materials community.

The Foundation's profile as a charitable organization continues to grow, and 2018 saw an increase in the number of donors making contributions. This was also marked by an overall increase in donations and, notably, a year-end appeal which exceeded its campaign goal of \$100,000.

While the Foundation continued to support its ongoing initiatives, 2018 also saw the launch of new programs such as the William D. Nix Award and the TMS high-school outreach program, *Materials Explorers*[™].

None of these accomplishments would be possible were it not for the generosity of donors who recognize the importance of giving back to their professional community. Read on to learn more about the TMS Foundation's accomplishments in its anniversary year, and to find out how you can help us make an even greater impact in years to come.

Sincerely Lany WWarren

Garry W. Warren Chair, TMS Foundation Board of Trustees, Member, TMS Foundation Gold Society

2018 TMS FOUNDATION BOARD OF TRUSTEES

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Secretary James J. Robinson TMS Executive Director



2018 ANNUAL REPORT

OUR MISSION

The mission of the TMS Foundation is to support the development of professionals in the minerals, metals, and materials community within the context of our global society by providing scholarships to the field's most promising students and investing in the future of the profession and the industries it serves. The Foundation also funds programs that assist young professionals in attaining the highest level of technical, professional, and leadership development.

OUR PROGRAMS

Students

By supporting scholarships, travel grants, and educational enrichment programs for students, the Foundation helps remove barriers to education while encouraging a deeper involvement in the greater materials community.

Early Career Professionals

The TMS Foundation supports professionals at a key stage in their career development by offering professional recognition awards, opportunities presenting work and developing symposia, leadership development programs, and networking with Society leaders.

Established Professionals

Publicly recognizing the talent and achievements of professionals can help to boost their prestige in the field and support them in reaching their professional potential. Awards supported by the TMS Foundation encourage diversity within our professional field, outstanding mentors or educators, and distinguished achievements in specific fields.

Outreach Initiatives

The TMS Foundation also supports the *Materials Explorers*[™] high school outreach program and the TMS Bladesmithing Competition for students. Other STEM initiatives supported by the TMS Foundation include student participation in the Electronic Materials Conference and the ASM Foundation Materials Camps.



"The TMS Foundation has always provided great academic and career opportunities...engaging in various TMS events and activities was always very rewarding to me as I got more involved with my research community and received support and experience."

-Niaz Abdolrahim, 2018 Functional Materials Division Young Leader





TMS FOUNDATION 2018 FINANCIAL OVERVIEW

The TMS Foundation has continued to grow in scope and impact since its revitalization began in 2013. The financial information below provides two perspectives on the TMS Foundation's performance in 2018:

- Donations (inclusive of new endowments being established): 2018 saw the TMS Foundation raise the 2nd most donations in all the years of the revitalization
- Program Expenditures: 2018 saw the TMS Foundation issue more dollars in gifts than any other year of the revitalization



Total Program Expenditures: \$172,409				
	% Total	Value		
K-12 Outreach	35%	\$60,12		
Materials Student Support	44%	\$76,63		
Young Professional Support	14%	\$22.00		
	14/0	45,9		

2018 TMS Foundation

Program Expenditures

7%

35%

K-12 Outreach

\$11,661

14%

Career Awards

Materials Student Support > 44%

Young Professional Support

Career Awards

	% Total	Giving
Individuals	69%	\$352,450
Organizations	12%	\$61,272
TMS Contribution	19%	\$100,000
Total Contributions		\$513,722

Total Program Expenditures	\$172,409

7%

The TMS Foundation is a unit of The Minerals, Metals & Materials Society (EIN: 25-1484913), which is a qualified 501(c)3 tax-exempt organization. Official registration and financial information may be obtained from the Pennsylvania Department of State by calling toll-free, within Pennsylvania, 1–800–732–0999. Registration does not imply endorsement.

2018 ANNUAL REPORT

DONOR RECOGNITION

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In addition to special donor groups such as the **40/40 Club** for young professionals and the **1871 Legacy Circle** for individuals who have provided for the TMS Foundation through planned giving, the TMS Foundation celebrates its donors through its **Lifetime Giving Honorific Societies** and the **Annual Giving Honor Roll**. With their generous contributions to the TMS Foundation, our donors are making a significant and permanent impact on the future of the minerals, metals, and materials professions. To view current members of both honor rolls, visit www.TMSFoundation.org/HonorRolls.



Garry Warren addressed newly inducted members of the TMS Foundation's Lifetime Giving Honorific Societies at the 2018 donor appreciation dinner, saying: "As donors, you share a common goal to support students and young professionals in the critical early years of their careers. Their contributions to research, academia, and industry will advance the global society. You are the top donors who are building the future of the materials professions. Thank you from the TMS Foundation and from the lives you touch."

ORGANIZATIONAL GIVING





Aurubis AG

Bognar and Company Inc.



American Institute of Mining, Metallurgical, and Petroleum Engineers



Arconic Foundation

ARCONIC

OUNDATION

Bognar and Company Inc.



Thermo-Calc Software AB (Sweden) Thermo-Calc Software (U.S.) Gopher Resource LLC

Wagstaff Inc.



25 YEARS OF GROWING THE COMMUNITY: 2018 ANNUAL REPORT



YOU CAN MAKE A DIFFERENCE

It's easy to contribute to the good work of the TMS Foundation. You can make a donation in one of these ways:

- **1.** Donate online: www.TMSFoundation.org/Contribute
- 2. Send a check, payable to the TMS Foundation, to the address below.
- **3.** Contact TMS Foundation staff to discuss your donation personally using the contact information below.

CONTACT US

Address: TMS Foundation The Minerals, Metals & Materials Society 5700 Corporate Drive Suite 750 Pittsburgh, PA 15237

Phone: 1–724–776–9000 Email: TMSFoundation@tms.org

Website: www.TMSFoundation.org





"As engineering professionals we improve the world around us today and in the near future through our daily work. By investing in the success of the next generation of engineering professionals, we are paving the way for a brighter future for our country and society in perpetuity."

- Paul R. Ohodnicki, TMS Foundation Donor



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WHERE WE'VE BEEN AND WHERE WE'LL GO

A JOM ROUNDTABLE ON KEY ISSUES IN ADDITIVE MANUFACTURING

ANN RITCHIE

The importance of materials science and engineering to additive manufacturing (AM) was an emerging topic of exploration when *JOM*: The Magazine published

the article, "Layers of Complexity" in its November 2014 issue. Through interviews, case studies, and a roundtable of experts, the future potential of the field was examined from a variety of angles. Many of the perspectives offered were energized and optimistic, although also realistic about the challenges facing widespread deployment of AM.

LAYERS OF CO

Much has changed since then and interest in the capabilities of AM has increased exponentially. On the fifth anniversary of that article's publication, it seemed fitting to assemble another expert panel to reflect on those changes and developments, while also looking forward to how AM will continue to impact the materials science and manufacturing landscape.

Background image by Santosh Rauniyar and Kevin Chou, "Melt Pool Analysis and Mesoscale Simulation of Laser Powder Bed Fusion Process (L-PBF) with Ti-6AI-4V Powder Particles", JOM, 71, 3, 2019.

MEET THE ROUNDTABLE PANEL



Allison M. Beese, associate professor at Pennsylvania State University, sits on the TMS Content Development and Dissemination Committee and the Additive Manufacturing Committee. She is the recipient of the 2018 AIME Robert Lansing Hardy Award.



David L. Bourell, the Temple Foundation Professor at University of Texas at Austin, is the founding chair of the Additive Manufacturing Committee and teaches the Additive Manufacturing Materials and Processes half-day workshop at multiple TMS events. He is a 2011 TMS Fellow.



Mohsen Seifi is the director of Global Additive Manufacturing Programs at ASTM International and adjunct assistant professor at Case Western Reserve University. He is a member of the Additive Manufacturing and Mechanical Behavior of Materials Committees.

NOVEMBER 2014 jom.tms.org

Energy and

TIMIS

Environment

AM BREAKTHROUGHS AND SETBACKS

Beese: One of the key breakthroughs has been the integration of real-time sensing equipment within AM machines, combined with the application of machine learning to process the resulting data. Eventually, the use of real-time sensors, along with understanding of the processstructure-property relationships, will have the potential to result in real-time process monitoring and correction.

Bourell: Also significant is the adoption of AM by large, multinational companies, including Hewlett Packard. This is already impacting performance and value. In addition, custom product design is making a renaissance. Examples include Gillette's custom razor handles, Mini Cooper's auto components, Dr. Scholl's custom insoles, and Deutsche Bahn's integration of AM to facilitate rapid production and distribution of legacy spare parts.

Beese: I am personally very excited about the potential for designing functionally graded materials to be fabricated via AM. This is an area that my colleague at Penn State, Zi-Kui Liu, and I have been working on. If we can understand phase formation in AM while mixing metals or metal alloys, we could eventually spatially tailor properties, such as strength, stiffness, thermal conductivity, or magnetic permeability within a single component by deliberately depositing different combinations of alloys at different locations within the component.

AM offers a huge opportunity for alloy design. New materials that precipitate out desired phases or grain morphologies/textures during AM could be designed to provide high strength, good ductility, or other properties we would like to see within components.

Bourell: Use of metals AM for consistent, reliable structural parts is among the hottest areas in materials these days. In the last five years, I am excited that serious researchers are studying low-cost AM technologies, such as binder jetting and materials extrusion. Producing service parts on these machines will have significant positive impact on part cost and AM adoption. Major challenges for service part manufacture are consistency and reliability of microstructure and properties; reduction of time/effort cost in post-processing, including removal or elimination of support structures; and full exploitation of the design freedom AM offers.

WORKFORCE READINESS

Seifi: In 2017, ASTM conducted a virtual workshop to gather expert input on education and training gaps. Some major takeaways included the need for better understanding of processproperty relationships, such as AM-specific defect mechanisms and impacts on mechanical properties; gaps in information sharing and collaboration among industry, academia, and professional societies; and a need for more hands-on training opportunities. Most courses are offered online only, due to cost and/or safety concerns, and do not give participants firsthand experience to discover AM strengths and limits.

Beese: People who design the AM machines, as well as those who use them, should be aware of the range of science and engineering considerations involved in making components. However, educational programs often cannot cover everything relevant to the AM process. Also, since the technology continues to evolve and advance, it's challenging to keep course content updated to reflect the current state of the art. So, courses and programs need to constantly evolve.

Seifi: A major difficulty is that the community does not have a good program to teach standards or to show the big picture of how AM connects with other related disciplines. AM encompasses materials science, mechanical engineering, computer science, and other areas, and is closely tied to Industry 4.0 disciplines such as big data, robotics, and the Internet of Things. The boundaries between AM and these disciplines are disappearing, and it is important to take this into account.

ASTM recently launched an Education and Workforce Development (E&WD) program through the ASTM AM Center of Excellence (CoE) with three phases. In phase 1, we assessed AM community needs by analyzing the global activity landscape and developing a workforce workshop. We identified needed skills for the AM workforce, gaps in workforce development activities, and the role of stakeholders. In phase 2, the AM CoE developed a roadmap to guide the development and implementation of the E&WD program and a strategy for designing and developing courses that capitalizes on partner expertise. We are now in phase 3, training the workforce by convening a series of workshops in conjunction with the large events such as biannual ASTM F42, Additive Manufacturing Technologies Committee standardization week in conjunction with ISO TC261. This three-phase approach of needs assessment, planning, and program execution provides a good example for the community to follow in developing training programs.

Beese: Societies and universities are offering short courses to introduce people to AM. For example, Penn State has created a master's degree program in additive manufacturing and design, which was designed to educate the future AM workforce, providing a deep dive into the multidisciplinary aspects of AM. This program also provides a hands-on lab course to give participates experience in building parts with AM, heat treating them, and characterizing them.



THE CURRENT STANDARDS LANDSCAPE

Beese: A challenge with standardization is the number of variables that go into each build, which includes not only the prescribed variables, such as laser power, scan speed, layer height, or powder/wire feed rate, but also things that the machine operator does not necessarily control. For example, scan strategy, which is typically selected by the machine and not the user, directly impacts the thermal history within a component being built. Additionally, if the laser calibration differs between builds, or drifts with time, the processing conditions actually used may be different than those intended.

Finally, many machines are not truly open, which may make sense from a business standpoint, but from a scientific standpoint, we need to be able to alter parameters and monitor the process to develop the fundamental science understanding needed to advance or more widely adopt AM.

Seifi: Currently, it can take anywhere from one to three years for a new standard to be developed due to the nature of consensus-based development of standards, which is too slow to keep up with the rapid pace of AM technology. Standardization and R&D work are often disconnected from one another, which can lead to duplication of work as multiple industry stakeholders independently address the same challenges. Ultimately, this slows down the development of the field and increases the time to market for new technologies because foundational knowledge is not being shared.

There are several interconnected efforts to address these challenges. ASTM created Committee F42 on AM Technologies that is now working collaboratively with ISO to develop AM standards. The AM CoE has also begun conducting R&D specifically focused on standard gaps.

We encourage organizations to contribute to the acceleration of standardization by looking for opportunities to share pre-competitive research and participate in round-robin studies that could benefit the whole field.

- Mohsen Seifi, ASTM International

Accelerated AM standards development is the central focus area of the AM CoE. America Makes, one of the Manufacturing USA institutes, outlined the most critical AM standards gaps identified by the community and assigned responsibility to fill those gaps to specific organizations, including ASTM. We are addressing these gaps. A roadmap detailing the AM CoE's R&D efforts and plans will be available to the community in 2019—Through the first round of R&D projects, we have been able to contribute in filling 13 standards gaps from the America Makes roadmap and enhance 16 existing standards.

We encourage organizations to contribute to the acceleration of standardization by looking for opportunities to share pre-competitive research and participate in round-robin studies that could benefit the whole field. Individuals with AM expertise can also participate on standards developing organization (SDO) technical committees, like ASTM's F42.

Bourell: We are much further along today than five years ago. This includes strong programs within ASTM and ISO, the creation of pathways for joint development of standards within ASTM/ISO, and the creation of the Additive Manufacturing Standardization Collaborative (AMSC) with contributions from ANSI and America Makes. The challenge now is to maintain a collaborative spirit and write the identified standards.

A key issue that persists in the adoption of AM is qualification and certification both with respect to the adoption of known alloys into additively manufactured components and also as a barrier to the design, development, and adoption of completely new alloys. — Allison M. Beese,

Pennsylvania State University

RITCHIE

QUALIFICATION AND CERTIFICATION

Beese: A key issue that persists in the adoption of AM is qualification and certification both with respect to the adoption of known alloys into additively manufactured components and also as a barrier to the design, development, and adoption of completely new alloys.

Seifi: ASTM is always looking at current progress in qualification and certification. According to an internal landscape analysis we did in early 2019, although third-party certification serves a critical role in AM, there are not yet any full-fledged AM certification programs addressing the wide range of AM materials, parts, and processes. Those programs that exist typically focus on specific AM parts in select industries, leaving organizations to conduct internal qualification processes on their own. The most critical barrier to improving this situation is the complexity of AM itself—it is difficult for any single organization to cover the full range of AM parts and address all related qualification needs.

Beese: The key properties that need to be qualified vary with application. Traditionally, in the cases of both qualification and material certification, certain properties are verified within a given lot of material. For example, if properties like strength, ductility, or fatigue life were being qualified for a traditionally processed metal ingot, the corresponding test specimens, typically defined by ASTM or ISO standards, would be extracted from material within the same lot, and tested. However, this cannot be done in AM. New testing need to be defined.

Additionally, standard characterizations or specimen geometries are not yet agreed upon to certify materials. Due to the complexity of components made by AM, standards must be defined for a range of potential situations.

Seifi: Standards provide the foundation of qualification and certification programs. Without strong standards, it is impossible to complete qualification and certification procedures. For this reason, supporting the development of high-priority standards is crucial to accelerating progress in these areas. Additionally, existing qualification and certification programs could receive support to work in a coordinated manner for example, by creating a third-party framework for them to follow for quality assurance.

TMS COMMUNITY SUPPORT AND INVOLVEMENT

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Bourell: In the past five years, TMS has made enormous strides including creating the Additive Manufacturing Committee, hosting several hundred presentations at the TMS Annual Meeting & Exhibition each year, and growing the TMS/AM community to more than 400 participants.

Seifi: TMS's studies on the materials genome/informatics and integrated computational materials engineering (ICME) have already made a positive impact on the community. America Makes is currently using an AM genome derived from the concept of the materials genome, and the AM industry increasingly uses informatics and ICME. These concepts will be critical to expanding AM into the Industry 4.0 concept, which includes big data, simulation, and system integration. TMS could further support these activities by conducting additional studies, holding expert workshops and symposia, and pursuing other activities that help promote these areas and increase the body of knowledge.

Beese: The TMS short course on Additive Manufacturing Materials and Processes workshop exposes participants to AM processes for different material classes, talks about the modeling approaches being used for AM, and introduces the methods and metrics for evaluating structure and properties of additively manufactured materials.

The Additive Manufacturing Committee meets at both the TMS Annual Meeting & Exhibition and the Materials Science & Technology conference, providing an opportunity to shape future conferences. A suggestion is that TMS could facilitate a networking opportunity following the meeting to encourage further discussion. Newer participants would particularly benefit from the opportunity to interact with colleagues beyond technical sessions.

TMS members can get involved in the AM Committee, present their work at the annual meeting, and submit articles to *JOM*. Each year, *JOM* devotes an issue to AM.

Bourell: The rapid growth of AM is due in part to materials researchers "jumping on the bandwagon." To the degree that researchers bring their existing expertise into the field and apply it to address challenging problems in the AM field, we all benefit. I would encourage materials researchers to jump in to start making contributions.

Also significant is the adoption of AM by large, multinational companies, including Hewlett Packard. This is already impacting performance and value.

- David L. Bourell, University of Texas at Austin



A TMS TIMELINE OF LEADERSHIP IN AM

Additive Manufacturing (AM) is one of the fastest growing technical topics at the TMS Annual Meeting & Exhibition, with standing-room-only crowds routinely attracted to the keynote sessions. Beyond annual meeting programming, TMS has played a significant leadership role in advancing additive manufacturing knowledge and application over the last five years.



JOM began focusing its March issue to additive manufacturing and related topics. Several manuscripts associated with these special topics have become highly cited articles.





The Additive Manufacturing Materials and Processes half-day workshop has been held at multiple events since 2015 including the annual meeting. With lead organizer David Bourell, this introductory course has taught more than 300 participants since it was first introduced.



The Additive Manufacturing Committee has grown to become one of the largest technical committees at TMS since being established in 2016. It remains the only TMS committee that bridges all five technical divisions.



Technological Innovation in Metals Engineering

The Technological Innovations in Metals Engineering (TIME 2018) conference in Haifa, Israel was co-sponsored by TMS and included more than 100 presentations with additive manufacturing being a core topic. TMS will co-sponsor this conference again in 2020.



ADDITIVE MANUFACTURING BENCHMARKS

Additive Manufacturing Benchmarks (AM-Bench) was held in 2018 and became the first in a series of events focused on validating and improving the accuracy of model predictions and developing universally accepted quantitative measurement approaches for all additive manufacturing (AM) materials and methods.

2019

A half-day course on Additive Manufacturing Standards, Qualification, and Certification was introduced at the 2019 annual meeting. The lead organizer, Mohsen Seifi, created this course for people in the materials community already familiar with AM processes who want to learn more about standardization, qualification, and certification efforts.

Multiple studies recently released by TMS have also underscored the pivotal role of AM in the materials and manufacturing landscape. Examples of reports that reference the importance of AM include: Advanced Computation and Data in Materials and Manufacturing: Core Knowledge Gaps and Opportunities and Harnessing Materials Innovations to Support Next Generation Manufacturing Technologies. To download these and other reports for free, go to www.tms.org/studies.





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TMS meeting headlines

View all upcoming meetings online at www.tms.org/Meetings.

Other Meetings of Note

OTC Asia 2020 March 24–27, 2020 Kuala Lumpur, Malaysia

Offshore Technology Conference (OTC 2020) May 4–7, 2020 Houston, Texas, USA

The 11th International Conference on Molten Slags, Fluxes and Salts (Molten 2020) May 25–29, 2020 Seoul, South Korea

Technological Innovation in Metals Engineering (TIME 2020) June 2–4, 2020 Youngstown, Ohio, USA

The 5th International Congress on 3D Materials Science (3DMS 2020) June 28–July 1, 2020 Washington, D.C., USA

8th International Conference on Solid —> Solid Phase Transformations in Inorganic Materials (PTM 2020) June 29–July 3, 2020 Xi'an, China

The 14th International Symposium on Superalloys (Superalloys 2020) September 13–17, 2020 Seven Springs, Pennsylvania, USA

THE WORLD COMES HERE TMS 2020

149th Annual Meeting & Exhibition February 23–27, 2020 San Diego Convention Center and Marriott Marquis & Marina San Diego, California, USA Discount Registration Deadline: January 17, 2020 www.tms.org/TMS2020

- Registration includes access to the 9th International Symposium on Lead and Zinc Processing and 3rd Symposium on Electrometallurgy, both co-located at this year's meeting.
- John Mason of Solar Turbines Incorporated will deliver "Leveraging Materials Innovation to Drive Industrial Gas Turbine Performance and Secure a Sustainable Future" for the All-Conference Plenary.
- The new Materials and Manufacturing Innovation Luncheon presents lectures while you dine with colleagues.
- Visit the Exhibitors & Sponsors section of the TMS 2020 website to see the floor plan and reserve a booth.

Congress on



June 21–24, 2020 Philadelphia Marriott Downtown Philadelphia, Pennsylvania, USA www.SafetyCongress.org

- Visit the website to download a preliminary schedule, sign up for updates, and access details on keynote talks, plenary topics, and sessions.
- Organized by eight leading engineering professional societies and the National Academies, the congress offers the unique opportunity to learn and share best practices used by different industries and organizations for solving similar safety problems.



July 26–31, 2020 The Ohio State University, Ohio Union Columbus, Ohio, USA Discount Registration Deadline: June 15, 2020 www.tms.org/ICTP2020

- Join attendees from around the globe and across industry, academia, and government to discuss all aspects of metal forming science and technology.
- Keynote speakers and honorary symposia include some of the biggest names in the field.
- Nominations are being accepted for the Japan Society for Technology of Plasticity's ICTP Award for Young Researchers.



October 4–8, 2020 David L. Lawrence Convention Center Pittsburgh, Pennsylvania, USA Abstract Submission Deadline: March 15, 2020 www.matscitech.org/MST20

- Network with colleagues and be part of one of the most extensive MS&T technical programs yet approximately 100 symposia on a variety of topics.
- MS&T offers you an impactful, crossdisciplinary showcase for your work, with programming collaboratively developed by volunteer experts from TMS, the American Ceramic Society (ACerS), and the Association for Iron & Steel Technology (AIST).
- Visit the website for details and to sign up for updates.

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Classifieds

Whether you are seeking a new job opportunity or needing to fill an open position, the JOM Job Board provides companies, academic institutions, and other organizations with a valuable resource to post and search for job openings. For \$125 per column inch, your ad can be posted, searched, and viewed by thousands of qualified candidates. Questions on placing a JOM classified advertisement?

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AND ENGINEERING TEMPORARY INSTRUCTORS IN MATERIALS SCIENCE AND ENGINEERING

University of California, Davis

The Department of Materials Science and Engineering at the University of California, Davis invites applications for a pool of qualified temporary instructors to teach courses in our department should an opening arise. Screening of applicants is ongoing and will continue as needed. The number of positions varies from quarter to quarter, depending on the needs of the department.

The department offers BS, MS, MEng, and PhD degrees in Materials Science and Engineering (MSE) in the College of Engineering. The department educates students in the fundamental science and engineering principles relevant to materials, emphasizing the relationships between processing, nano/microstructure, characterization, properties, processing and design of advanced materials. The program trains students in the experimental and computational skills for a professional career, graduate study and advanced research in MSE. The duties will include (but are not limited to) teaching or co-teaching a course including: lecturing, holding office hours, grading and administering exams and coursework, managing and mentoring graders and teaching assistants, course preparation, holding discussion or lab sections and additional duties as needed.

Positions are typically part-time. Instructors teaching a course with three hours of lecture per week will normally be appointed at 33% time during the quarter; exact percentages depend on contact hours and other assigned duties. Please note: The use of a lecturer pool does not guarantee that an open position exists. See the review date specified in AP Recruit to learn whether the department is currently reviewing applications for a specific position. If there is no future review date specified, your application may not be considered at this time.

Consult <u>https://mse.engineering.ucdavis.edu/</u> or <u>https://recruit.ucdavis.edu/apply/</u><u>JPF03007</u> for our on-line application procedure and requirements. The positions will remain open until filled; but to assure full consideration, applications should be submitted no later than 11:59 pm PST February 24, 2020. We welcome applicants who have shown a commitment to educating and mentoring a diverse student body to expand opportunities and enhance personal growth, retention, and academic success.

UC Davis is an affirmative action / equal opportunity employer, and is dedicated to recruiting a diverse faculty community. We welcome all qualified applicants to apply, including women, minorities, individuals with disabilities, and veterans. UC Davis supports family-friendly recruitments. See: <u>http://academicaffairs.ucdavis.edu/wl-brochure.pdf</u>.

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Scientist Positions at IMDEA Materials Institute

IMDEA Materials Institute is a public research organization founded in 2007 by Madrid's regional government to carry out research of excellence in Material Science and Engineering by attracting talent from all over world to work in an international and multidisciplinary environment. IMDEA Materials has grown rapidly since its foundation and currently includes more than 120 researchers from 17 nationalities and has become one of the leading research centers in materials in Europe which has received the María de Maeztu seal of excellence from the Spanish government. The research activities have been focused in the areas of materials for transport and materials for energy and the Institute has state-of-the-art facilities for processing, characterization and simulation of advanced materials. More information can be found at https://materials.imdea.org/

The strategic plan of the Institute is aimed at expanding the research activities into the area of Materials for Health Care with the support of the Maria de Maeztu program. To this end, IMDEA Materials has opened two new positions of either Researchers (tenure-track) or Senior Researchers (tenured) in the following areas:

Materials and scaffolds for biomedical applications. He/she will bring expertise in the areas of cell culture, tissue growth, biocompatibility, bioactive agents for cell proliferation, etc. and is expected to take advantage of the current capabilities of the institute in advanced processing, characterization and simulation of materials to establish a multidisciplinary program. (Reference IC2019_01).

Biomechanics of biological tissues, including characterization, modelling and simulation of the mechanical behavior of healthy and pathological biological tissues and their interaction with implants, prosthesis and orthosis. He/she is expected to interact with the strong program in multiscale materials modelling in the Institute to expand its activities into the area of biological materials. (Reference IC2019 02).

Candidates should hold a doctoral degree in Materials Science (or related discipline) and demonstrate the ability to carry out independent research which combines high quality scientific research with technology transfer to industry, particularly for senior appointments. Leadership to develop an independent group within the institute's framework of research activities and good communication skills are required.

Interested candidates should submit their Curriculum Vitae (including complete contact information for two references) and a one-page statement of their research objectives through the institute's website (http://jobs.materials.imdea.org/). Selected candidates will be offered a five-years contract (for tenure-track appointments) with competitive salary and a generous start-up package.

> jobs.materials@imdea.org | tel. +34 91 549 34 22 C/ Eric Kandel, 2. Tecnogetafe. 28906, Getafe, Madrid (Spain)













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Classifieds

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NC STATE UNIVERSITY

Faculty Positions in Structural Materials Department of Materials Science and Engineering

The Department of Materials Science and Engineering at North Carolina State University is seeking to hire multiple outstanding individuals in open rank tenured/tenure-track faculty positions in the general area of structural materials.

Successful candidates will have achieved or be on a trajectory for international prominence, and senior candidates will have demonstrated vision and skills to lead collaborative, multidisciplinary research efforts. The successful candidate will be expected to establish a funded, independent research program as well as to collaborate with other researchers at NC State. The candidate will be expected to teach at both the undergraduate and graduate levels. In-depth knowledge of the processing/structure/properties/deformation physics of metallic materials is desired. The successful candidates will be experimentalists. Examples of possible research interests include the following:

- Processing of metallic materials, especially additive manufacturing
- Alloying behavior and design
- Mcchanical behavior of materials in extreme environments
 Light-weight materials
- Deformation mechanisms of metallic materials with novel microstructures
- Microstructural modifications to optimize mechanical properties
- Refractory alloys for elevated temperature applications

A Ph.D. degree in Materials Science and Engineering or a related field is required (must have by the date of hire), as well as demonstrated ability in teaching and research. We also value individuals who demonstrate a commitment to fostering creative teaching and instructional methods to enhance our undergraduate and graduate curricula.

Faculty have numerous opportunities for engagement with major research centers and facilities such as the NC State Analytical Instrumentation Facility, Research Triangle Nanotechnology Network, DOE PowerAmerica Institute, the ASSIST NSF Engineering Research Center, the Center for Additive Manufacturing and Logistics, the NSF Center for Dielectrics and Piezoelectrics, and the NC State High-Performance Computing facility.

The Materials Science and Engineering Department at NC State is a top 20 department with 27 faculty, and about 150 undergraduate and 150 graduate students. The department is located on the NC State Centennial Campus in Raleigh, North Carolina. Raleigh is typically listed as one of the best cities in which to live, and is known for its mild climate, vibrant cultural community, affordable housing, and excellent business climate. It is part of the thriving Research Triangle area.

Candidates must provide a cover letter, curriculum vitae, a research statement, teaching statement, and contact information for references. These materials may be submitted online at: https://jobs.ncsu.edu/postings/122419 (reference position number 00000625). Inquiries are invited and may be directed to the search chair at structural-search@ncsu.edu.

If you have general questions about the application process, you may contact Human Resources at (919) 515-2135 or workatncstate@ncsu.edu. Individuals with disabilities requiring disability-related accommodations in the application and interview process, please call 919-515-3148.

NC State University is an equal opportunity and affirmative action employer. All qualified applicants will receive consideration for employment without regard to race, color, national origin, religion, sex, gender identity, age, sexual orientation, genetic information, status as an individual with a disability, or status as a protected veteran.





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call for papers

JOM is seeking contributions on the following topics for 2020. For the full Editorial Calendar, along with author instructions, visit www.tms.org/EditorialCalendar.



May 2020: Manuscript Deadline: December 1, 2019

Topic: Advancing Development and Application of Superalloys

Scope: This topic focuses on the current advances in the development and application of Ni- and Co-based superalloys. Areas of interest may include (but are not limited to): alloy development, advanced processing, deformation behavior, structure-property relationships, long-term stability, environmental damage, and joining.

Editor: Martin Detrois

Sponsors: High Temperature Alloys Committee

Topic: Emerging Mechanisms for Enhanced Plasticity in Magnesium

Scope: This topic covers emerging methods that overcome this limitation. The scope is inherently multi-scale, ranging from fundamental mechanisms at the atomic/crystal defect level, up to large-scale production techniques. Optimizing mechanical properties via microstructure and crystallographic texture modification are considered; chemistry control and alloying, casting, powder-based strategies, as well as thermomechanical processing, are addressed. **Editors:** Petra Maier and Jishnu J. Bhattacharyya **Sponsors:** Magnesium Committee

Topic: Heat Transfer Utilization in Pyrometallurgy Scope: This topic covers some of the fundamentals and applications of heat transfer in pyrometallurgy. In particular, this topic aims to highlight how the knowledge and investigation of heat transfer modes drive furnace design and operation. Included are practical applications to industrial furnaces, with an emphasis on furnace heat management and heat utilization for process optimization. **Editors:** Camille Fleuriault and Joseph Grogan **Sponsors:** Pyrometallurgy Committee

Topic: In-Situ Characterization Techniques for Investigating Nuclear Materials

Scope: For this topic, we are soliciting papers on insitu experimental techniques at all length scales probing mechanical, chemical, thermal, or electrical responses, as well as irradiation damage. Papers that include modeling and simulation are welcome, though computational-only papers will not be accepted.

Editors: Clarissa Yablinsky, Peter Hosemann, David Frazer, and Shradha Agarwal **Sponsors:** Nuclear Materials Committee

June 2020 Manuscript Deadline: January 1, 2020

Topic: Advanced Characterization of Interfaces and Thin Films

Scope: This topic focuses on the advanced characterization of materials interfaces at atomic and nanoscales in metal, alloys, ceramics, and polymers by various in-situ and ex-situ experimental techniques, such as x-ray and neutron diffraction, scanning electron microscopy, transmission electron microscopy, and atomic force microscopy. This topic also involves the understanding of materials interfaces by theoretical modeling approaches that allow the study of these processes on the atomic and molecular level. **Editors:** Ritesh Sachan, Manuel Roldan Gutierrez, and Amit Pandey

Sponsors: Thin Films and Interfaces Committee

Topic: Electrochemical Energy Conversion and Storage

Scope: Papers are sought on topics related to, but not restricted to: solid oxide and proton exchange membrane fuel cells, electrolyzers, batteries for energy storage, and hydrogen storage. Papers can address issues related to electrode, electrolyte, and interconnection materials; electrochemical processes at electrodes and electrolyte interfaces; catalysts and catalytic mechanisms; infiltration to enhance catalytic activity and reduce poisoning effects; durability issues; and advances in characterization and modeling techniques.

Editors: Soumendra N. Basu and Partha P. Mukherjee **Sponsors:** Energy Conversion and Storage Committee



call for papers

Topic: Metal and Polymer Matrix Composites

Scope: This topic will cover recent progress in metal and polymer matrix composites, including: fiber-reinforced composites; natural fiber reinforced composites; solid and hollow particle reinforced composites; nanocomposites; fabrication methods and surface modification of micro- and nanoscale reinforcements; development of processing methods for composite materials; and modeling and simulation. **Editors:** Nikhil Gupta and Tomoko Sano **Sponsors:** Composite Materials Committee

Topic: Quantum Materials for Energy-Efficient Computing

Scope: Quantum materials hold great potential for becoming crucial components of future generations of computers. This special topic covers various state-of-the-art computational techniques, such as density-functional theory calculations that provide deeper understanding of quantum materials and accelerate their discovery. **Editors:** Houlong Zhuang, Shawn Coleman, Srikanth

Patala, Jacob Bair, and Sugata Chowdhury **Sponsors:** Computational Materials Science and Engineering Committee

July 2020 Manuscript Deadline: February 1, 2020

Topic: Characterization of Amorphous Materials Scope: This topic will include, but is not limited to, characterization of amorphous solids and possibly liquids using advanced analytical techniques such as electron microscopy, x-ray radiation, thermal analyses, spectroscopy, atom probe tomography, etc. Particular emphasis will be paid to lesser-known characterization techniques used for amorphous materials.

Editors: Yunus Eren Kalay, Rajiv Soman, and Zhiwei Peng **Sponsors:** Materials Characterization Committee

Topic: Machine Learning Applications in Advanced Manufacturing Processes

Scope: This special topic focuses on reducing waste, energy usage and carbon emissions, and spurring innovation in materials development and production. Advances in digital manufacturing, process control, predictive maintenance, and automation can be realized by integration of data analytics and validated models to ensure product quality, optimize operations, enhance productivity, and improve efficiency.
 Editors: Donna Guillen, Judy Schneider, and Srikanth Patala
 Sponsors: Energy Committee; Additive Manufacturing Committee; Computational Materials Science and Engineering Committee

Topic: Recycling Silicon and Silicon Compounds Scope: Silicon and silicon compound recycling is needed for a cleaner and greener environment. These materials can be reused in the manufacturing of solar cells and panels and other industries such as electronic industries. The scope of this special topic is concerned with recycling of all types of silicon, silicon products, and silicon compounds including silicon wafers, silicon poly chunk, IC grade, ingots, IC flakes, etc.

Editor: Shadia Ikhmayies

Sponsors: Recycling and Environmental Technologies Committee

Topic: Thermodynamic Modeling of Sustainable Non-Ferrous Metals Production

Scope: Papers covering experimental investigations, thermodynamic modeling, metallurgical process optimization, resource efficiency and environmental issues, particularly those pertaining to non-ferrous metallurgical processes, are invited. Manuscripts intended for a broad readership and review papers are especially encouraged. **Editors:** Fiseha Tesfaye, Allie Anderson, and Mingming Zhang

Sponsors: Process Technology and Modeling Committee; Recycling and Environmental Technologies Committee

August 2020: Manuscript Deadline: March 1, 2020

Topic: Additive Manufacturing: Beyond the Beam Technology

Scope: This invited topic will explore print process and post-print processing variables of non-beam solid state print technologies, which determine the properties, application performance, economics and enable component functionality. These processes include but are not limited to: binder jetting, material extrusion, filament process, nanoinkjet printing and sintering.

Editors: Paul Prichard, Peeyush Nandwana, Matt Dunstan, James Paramore, and Kathy Lu

Sponsors: Powder Materials Committee; Additive Manufacturing Committee

Topic: Advanced Processing and Additive Manufacturing of Functional Magnetic Materials Scope: Papers are invited on advanced processing and advanced manufacturing of functional materials with particular emphasis on magnetic materials. In particular, papers addressing permanent magnets, magnetocaloric materials, soft magnets, magnetic shape memory alloys, and multiferroics are welcome. Additive approaches to similar classes of functional materials are invited as well. **Editors:** Scott McCall and Ikenna Nlebedim **Sponsors:** Magnetic Materials Committee

Topic: Metastable Phases and Phase Equilibria Scope: Invited authors will provide original research submissions on next-generation alloys enabled by the design and control of metastable phases. In these alloys, outstanding properties are achieved through a combination of carefully tailored chemical composition and thermal processing. Examples include metastable austenite in TRIP, TWIP and Q&P steels, beta-stabilized titanium alloys, gamma double prime precipitates in nickel superalloys, high entropy alloys, and spinodal decomposition during aging of aluminum alloys. **Editors:** Gregory Thompson, Raj Banerjee, Eric Lass, and Bij-Na Kim Lee

Sponsors: Phase Transformations Committee



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